Charge Sharing Studies With a Laser Setup

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Outline

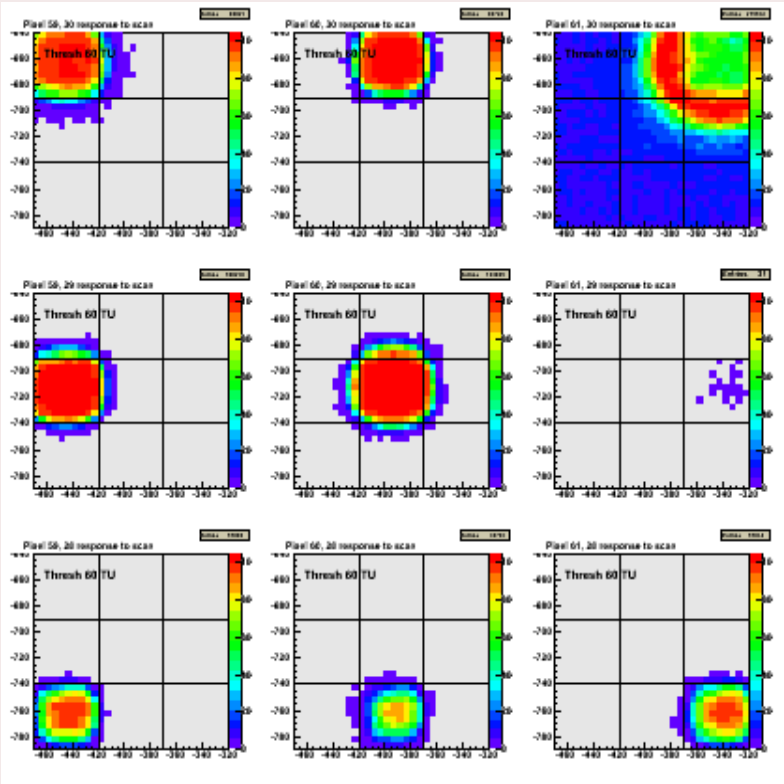
Laser setup

- Many thanks to Matt for setting everything up, and Paul for taking the data !
- In the following:
  - 10 bunch crossings (BX) per bunch train (BT),
  - laser fires at 2.5 μs (7^{th} BX),
  - 1000 BT per position,
  - X-Y stage moved by 5 μm steps, in x and y,
  - $150 \times 150 \mu m^2$ area scanned, centred on a given pixel,
  - several threshold values studied,
  - x-y 2D-histogram with bin content = signal recorded in the studied pixel when the laser was fired in (x,y).
  - display the results for all 9 pixels.

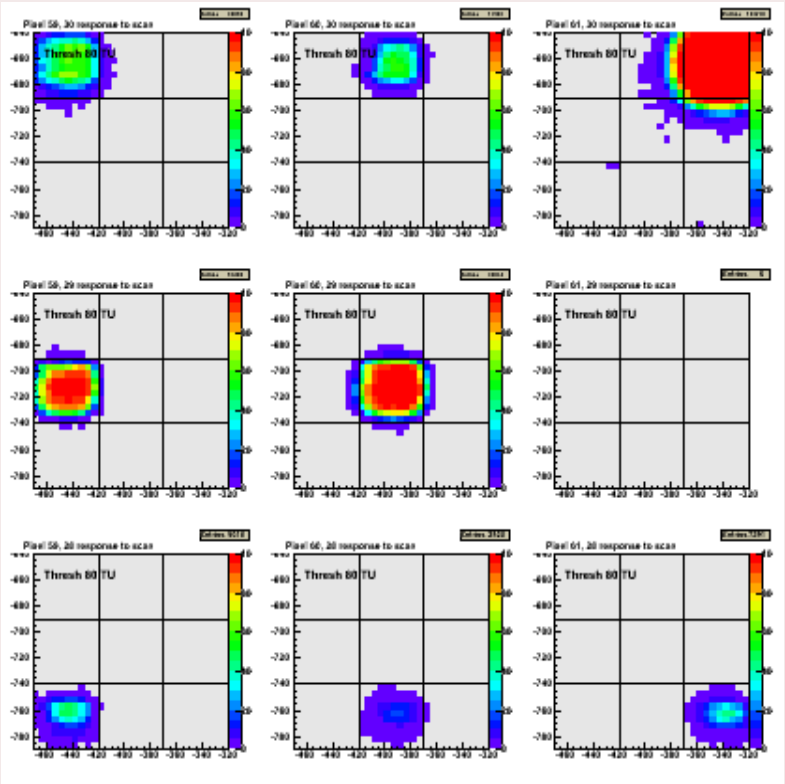
Random pixels, low threshold

Centre pixel: 60,29 (Peds [-8,-11,-2,13,16,-53,12,9,47] TU)

Threshold 60 TU

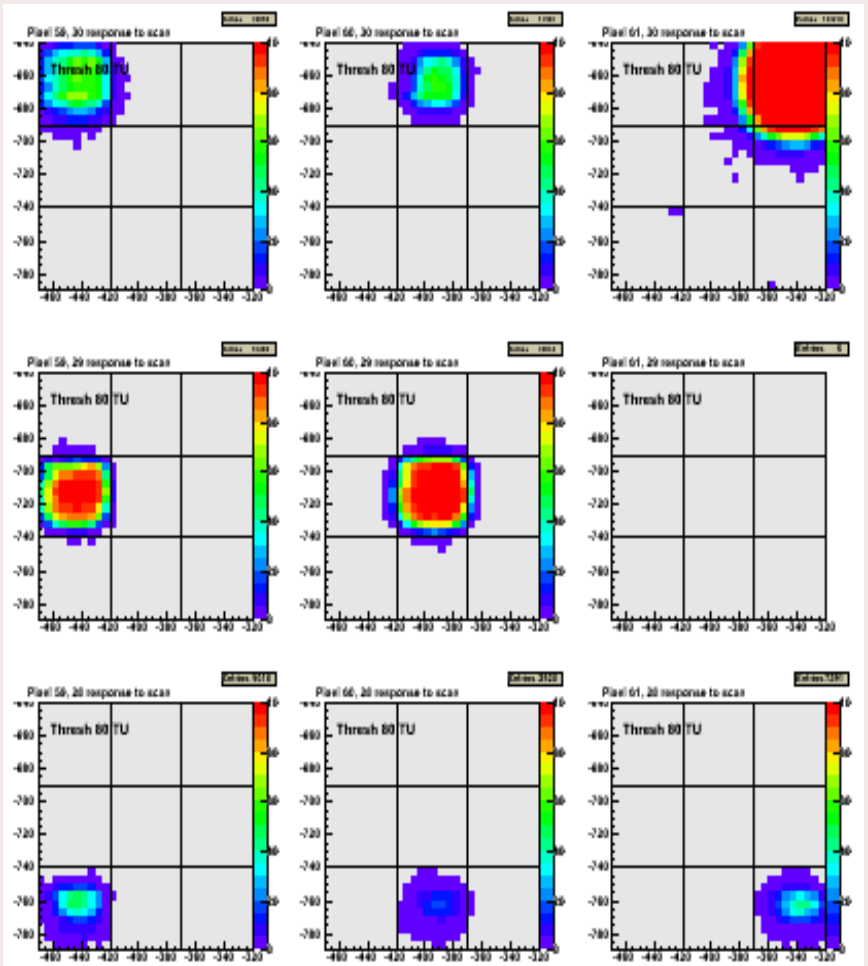


Threshold 80 TU

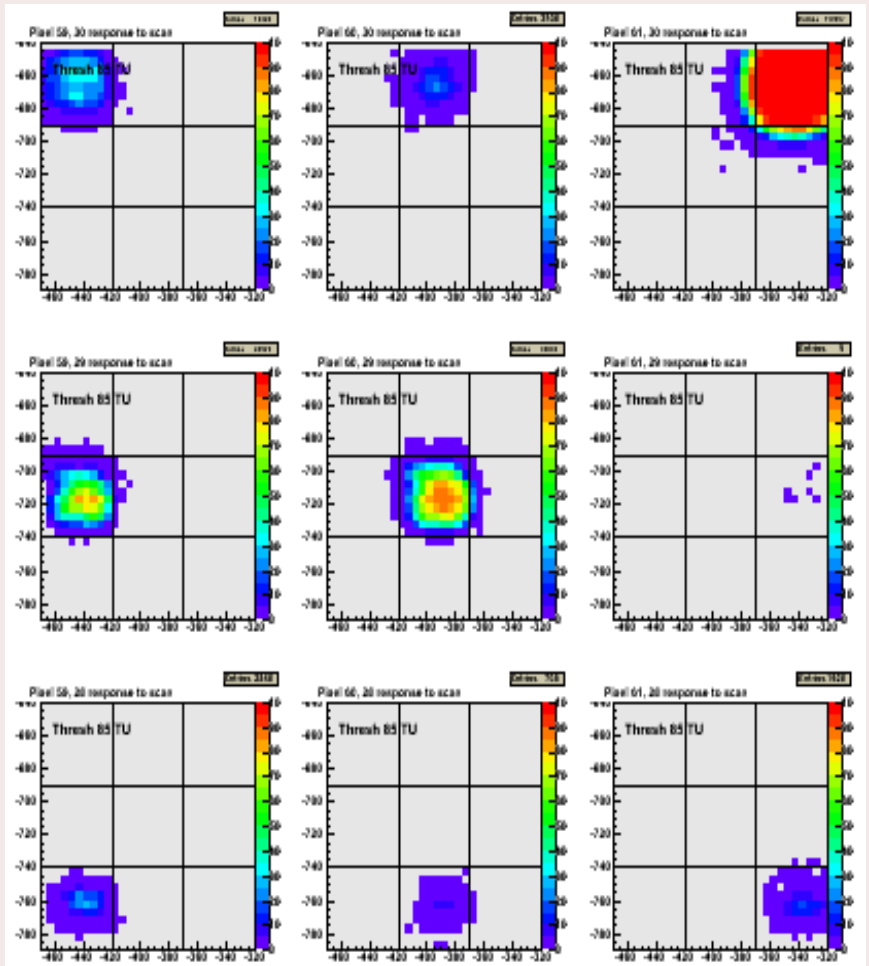


Higher threshold : expected behaviour (!)

Threshold 80 TU

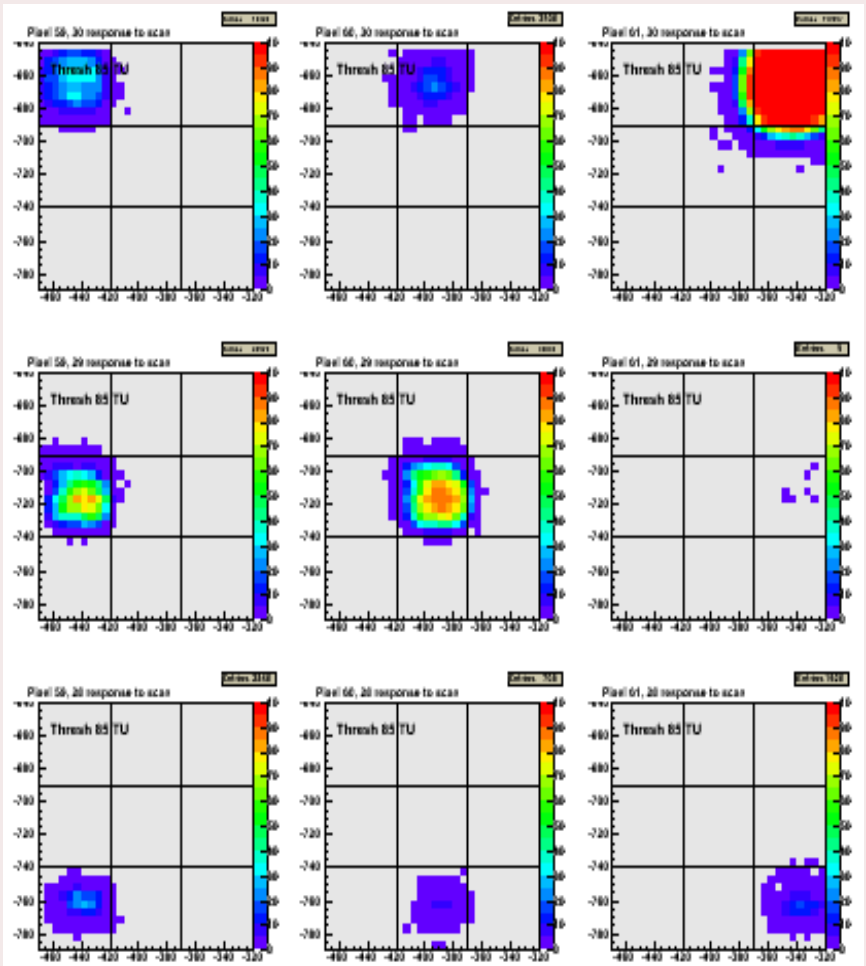


Threshold 85 TU

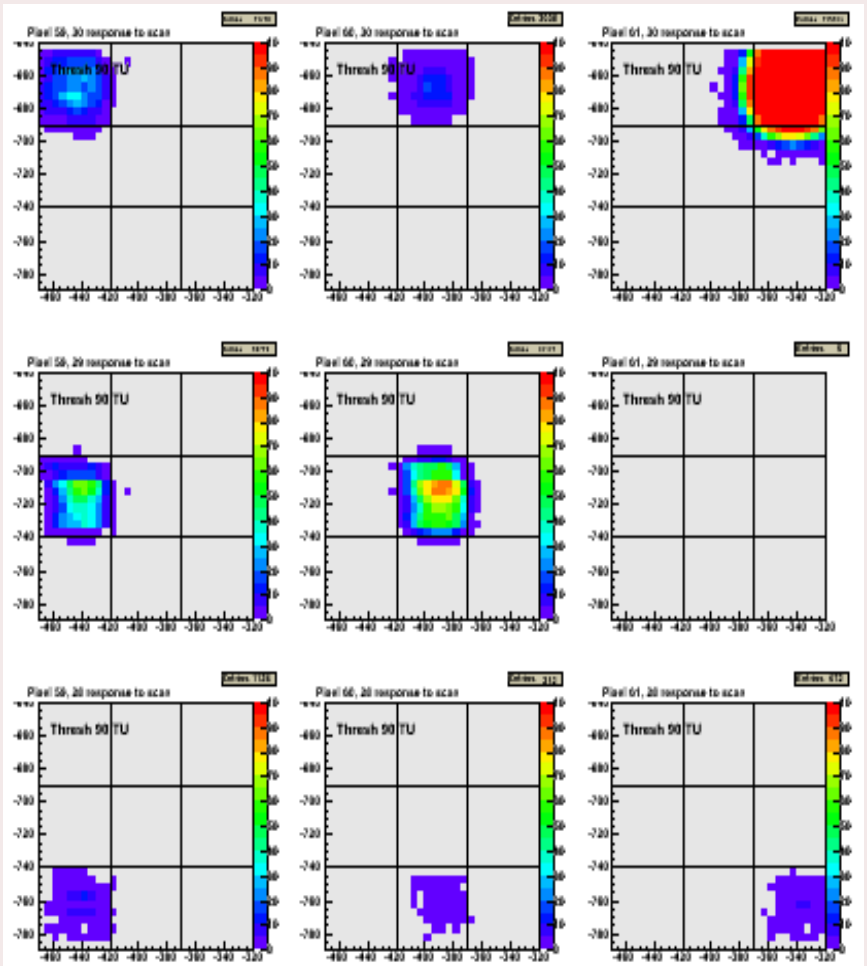


Results, continued...

Threshold 85 TU

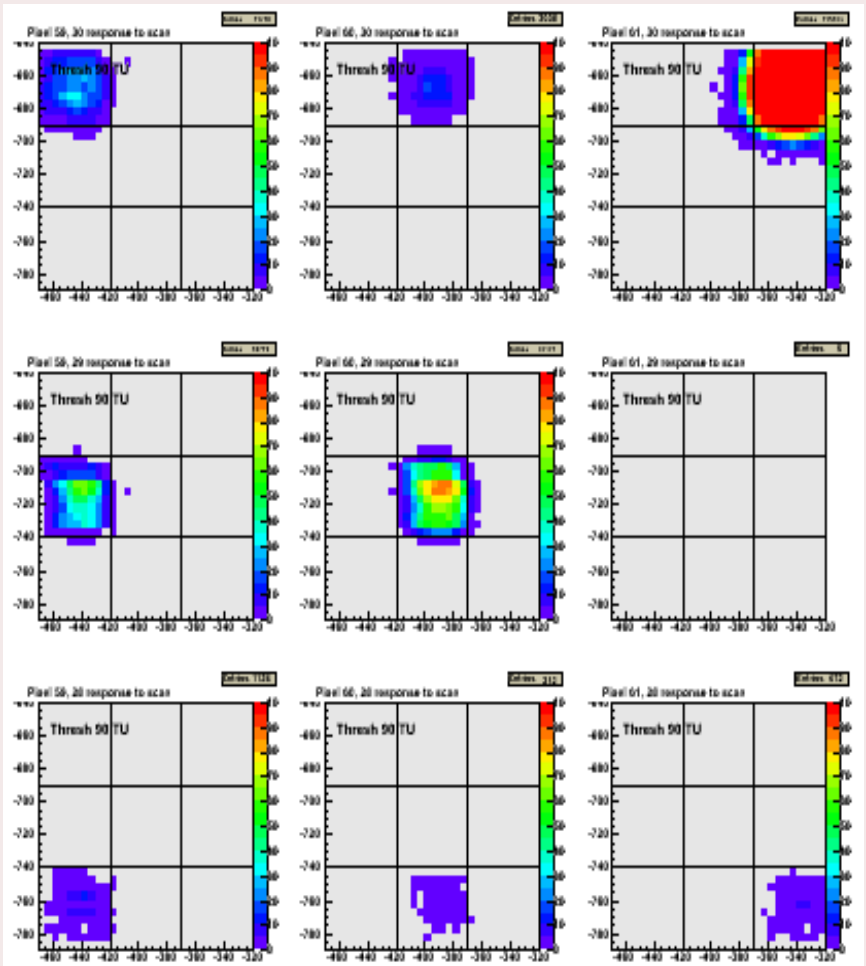


Threshold 90 TU

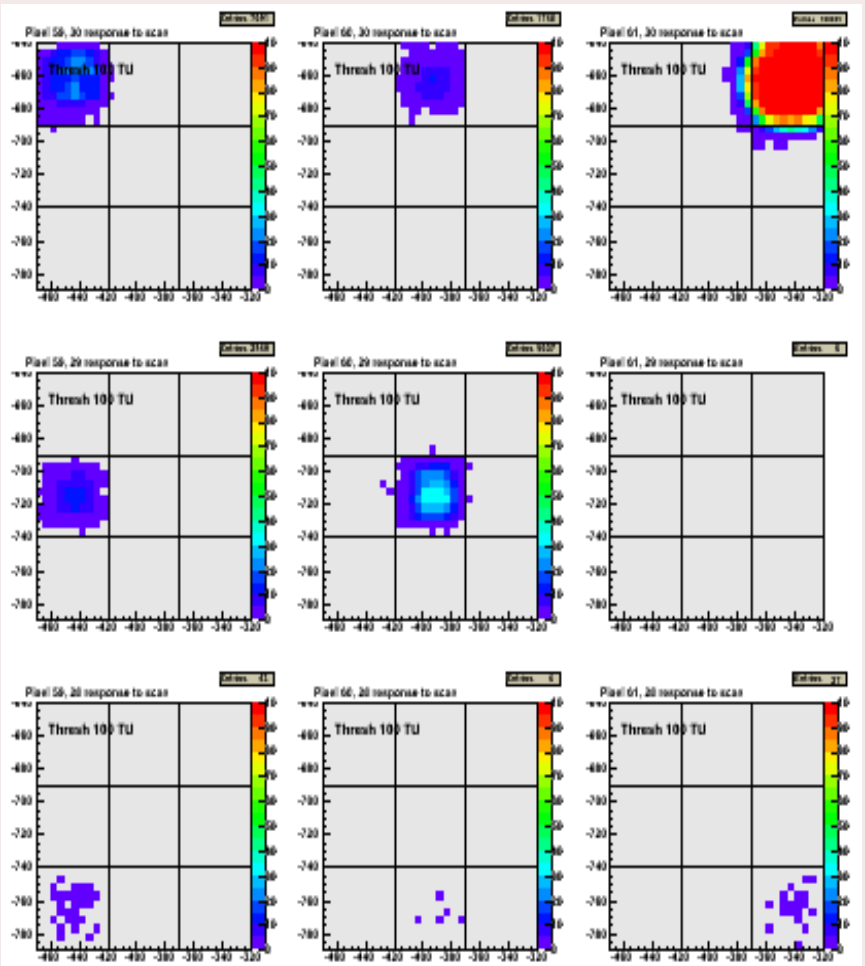


Results, continued...

Threshold 90 TU

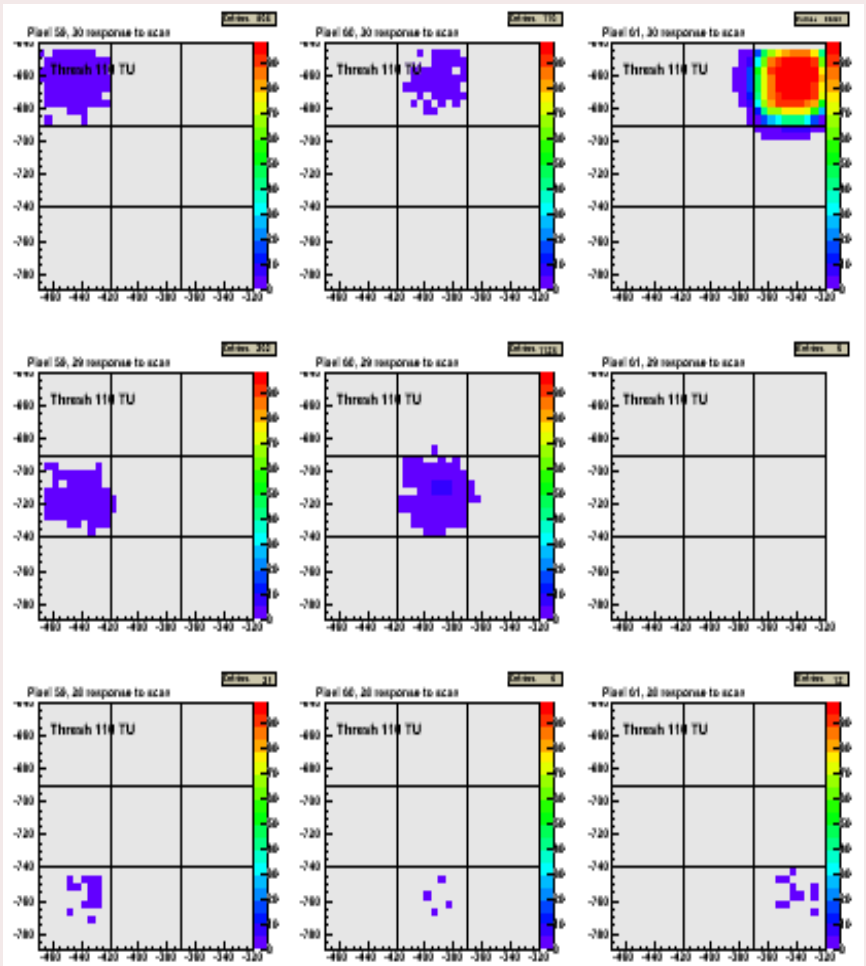


Threshold 100 TU

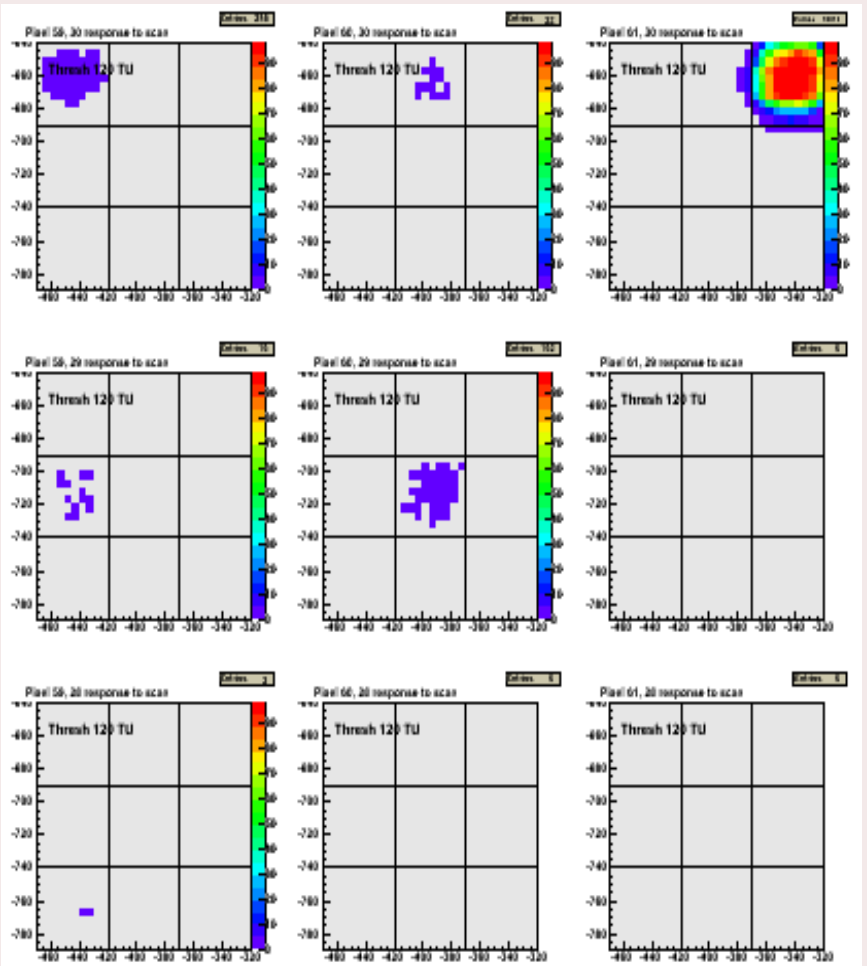


Results, continued...

Threshold 110 TU

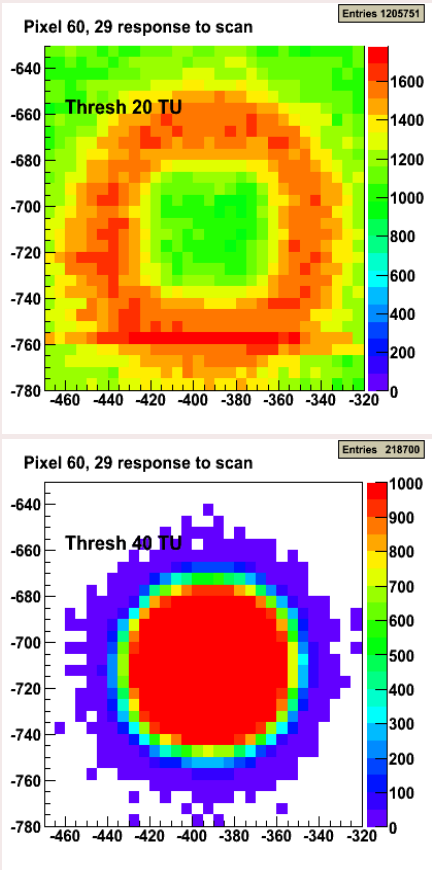


Threshold 120 TU

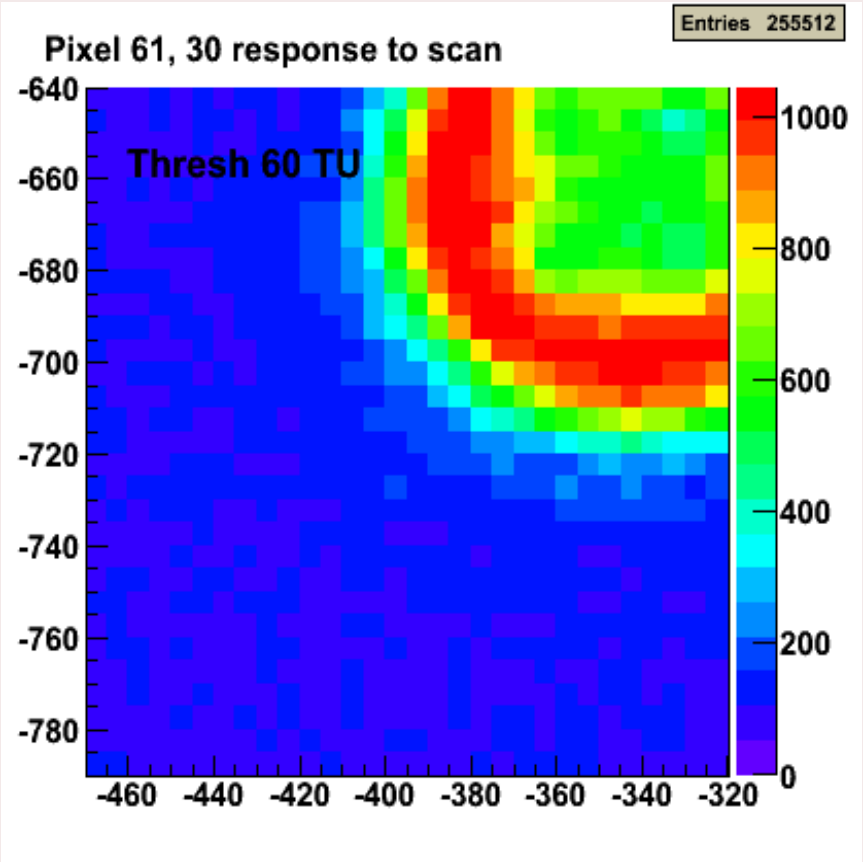


Low threshold: more sensitive outside of the pixel ??

Threshold 20 (4) and 40 (24) TU



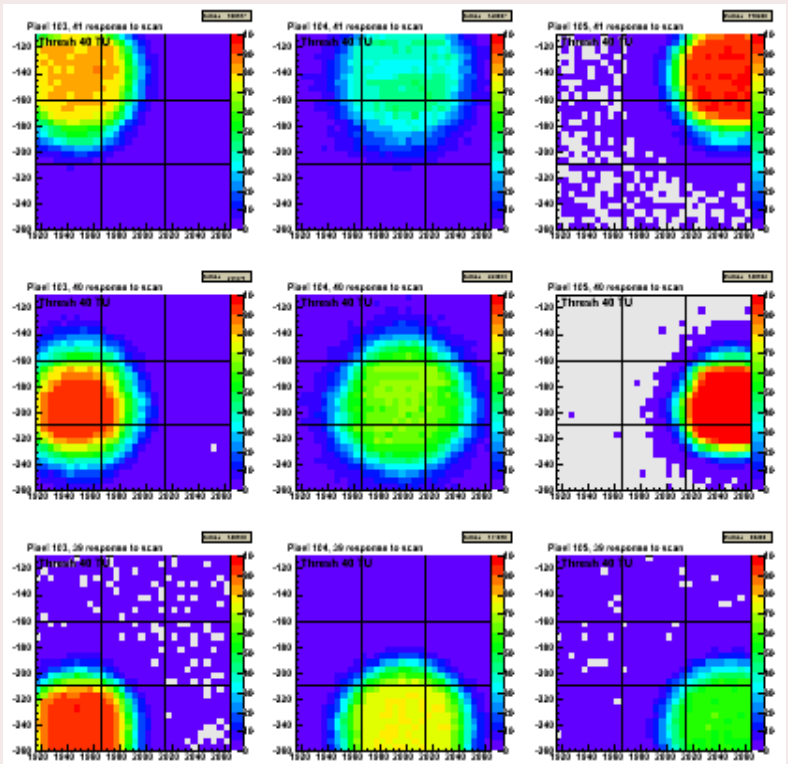
Threshold 60 (13) TU, pixel 61,30



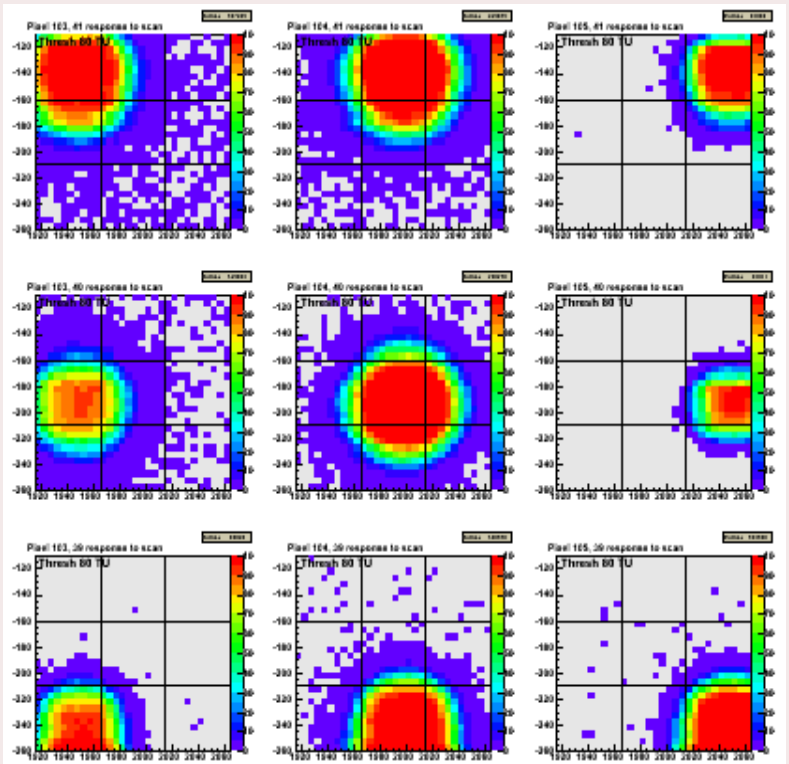
Random sampler pixels, low thresholds

Centre pixel: 103,39

Threshold 40 TU

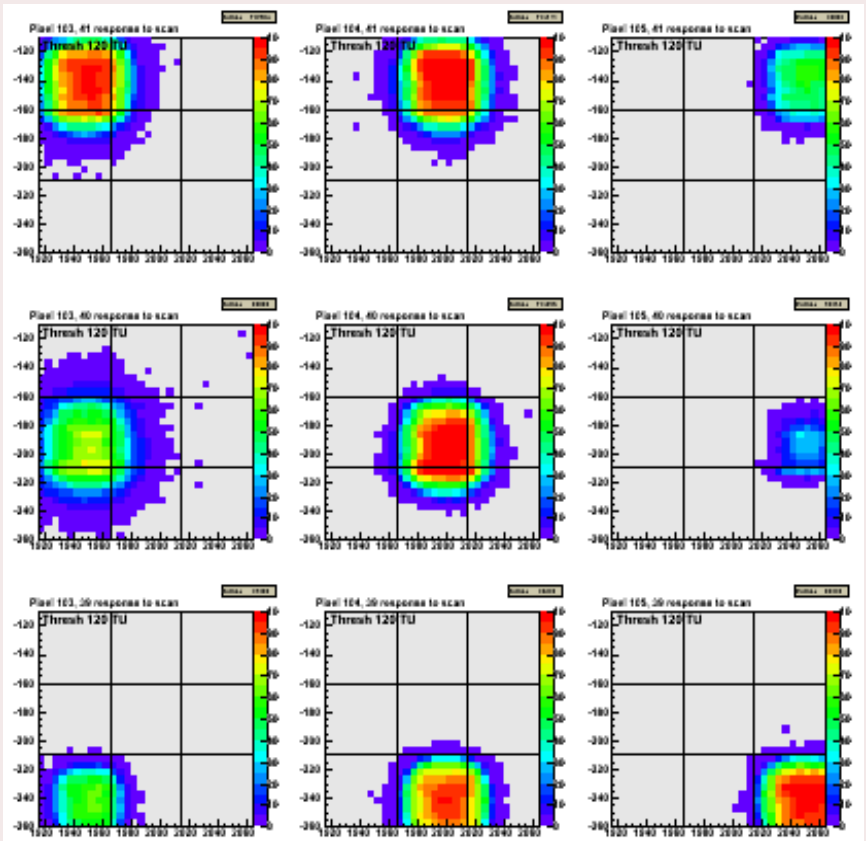


Threshold 80 TU

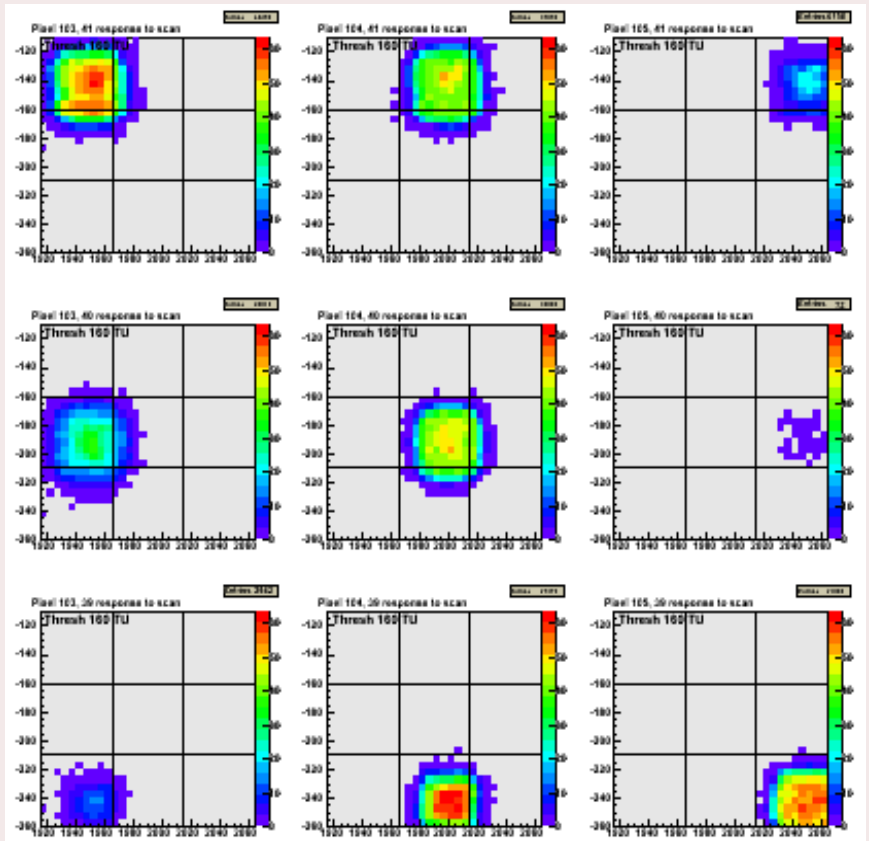


Random sampler pixels, high thresholds

Threshold 120 TU



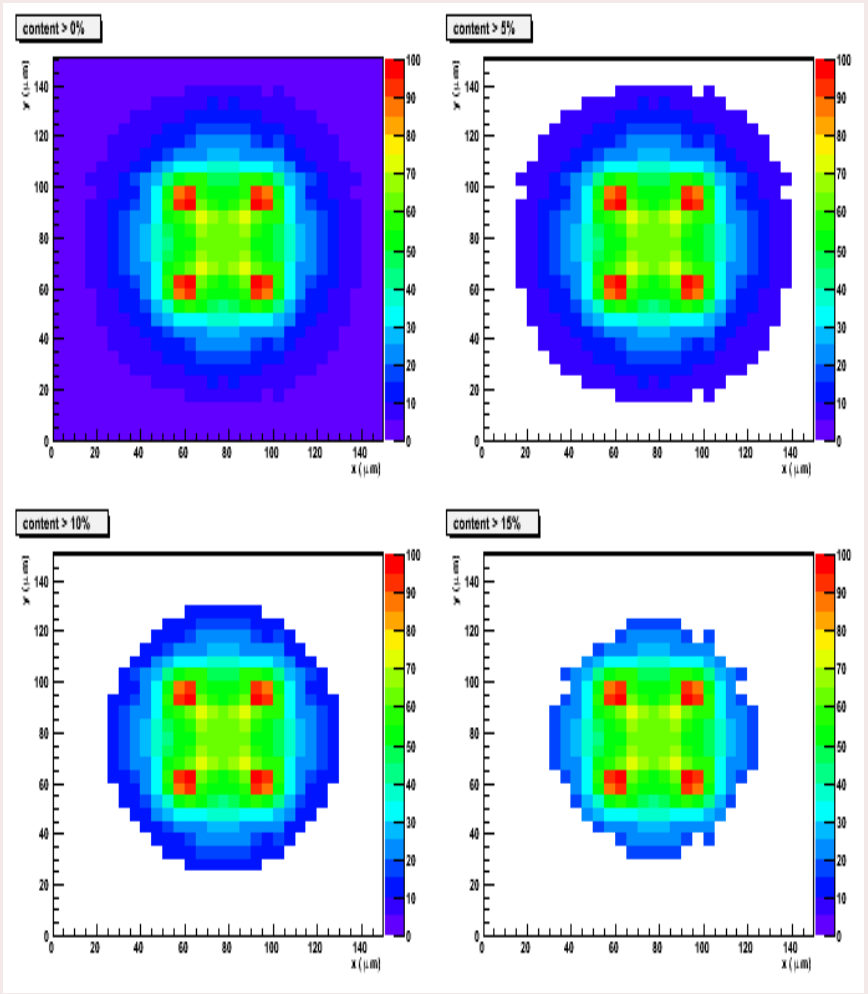
Threshold 160 TU



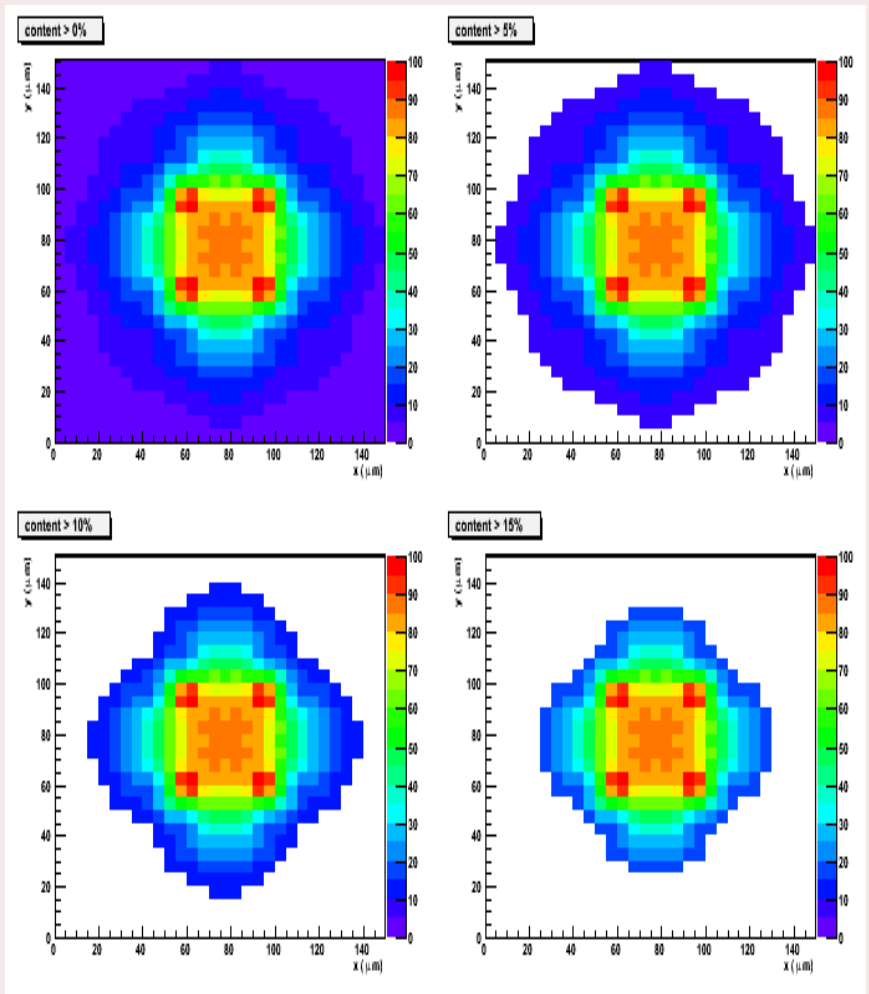
Outline

Full simulation, by comparison ...

GDS full simulation

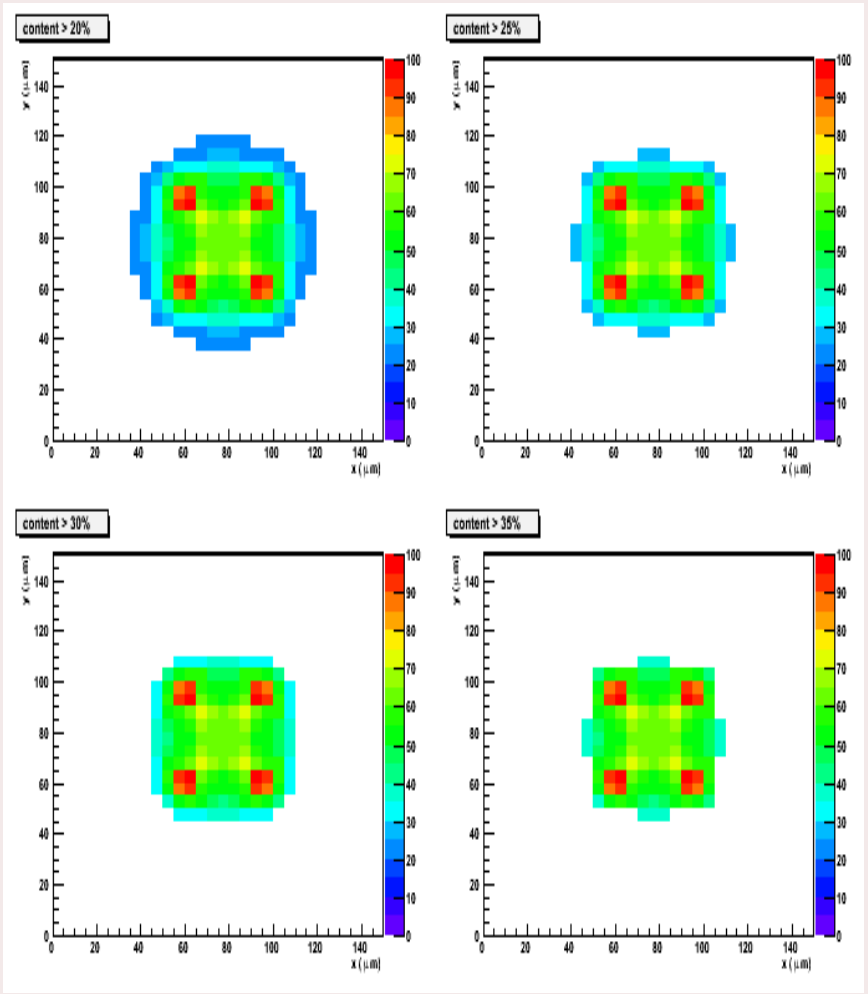


GDS assuming perfect p-well

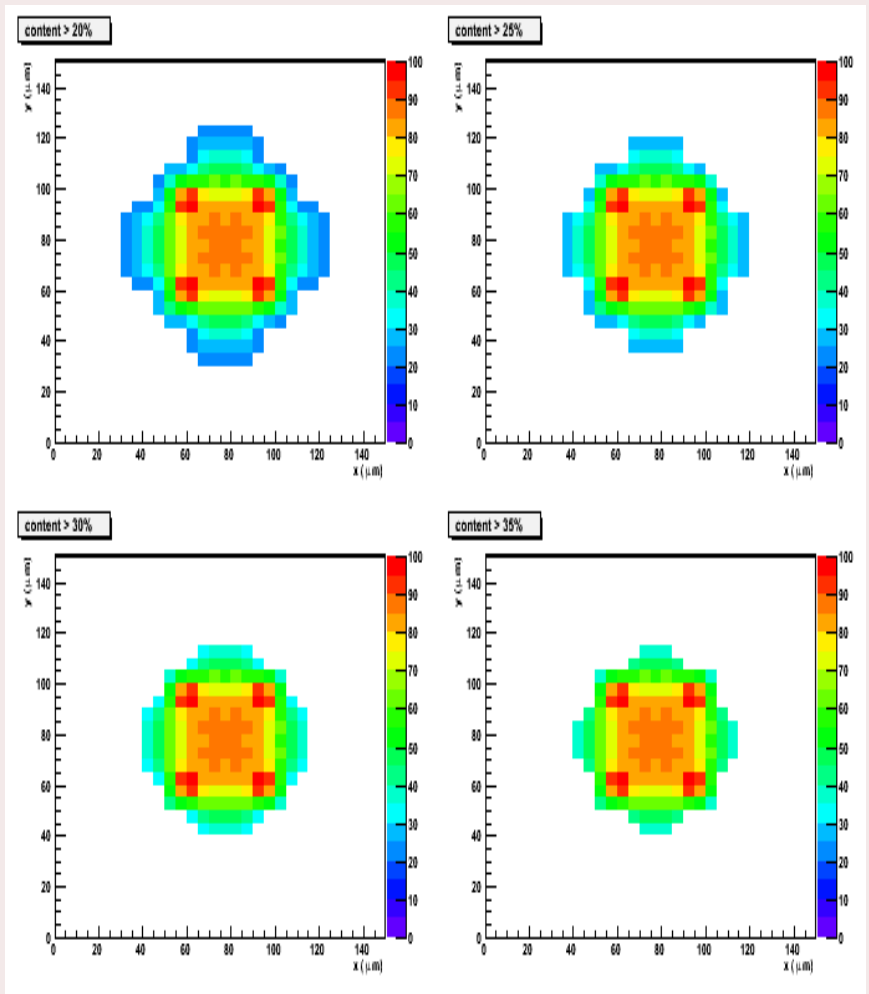


Full simulation, by comparison ... , continued...

GDS full simulation

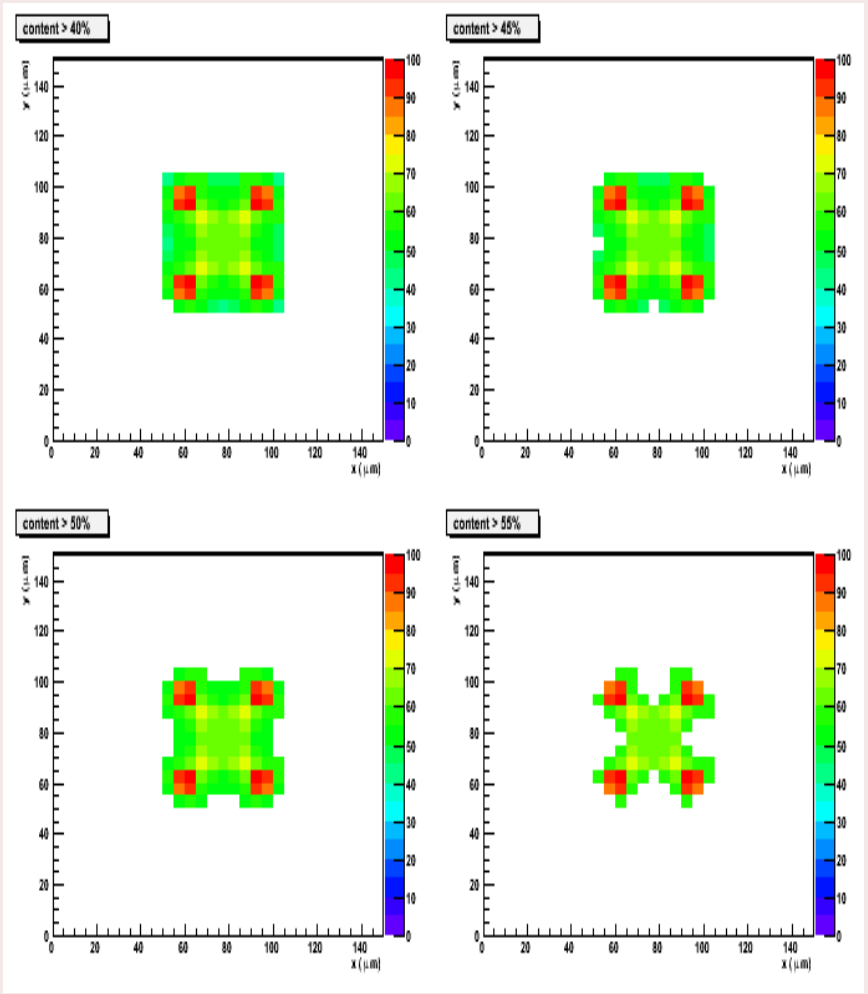


GDS assuming perfect p-well

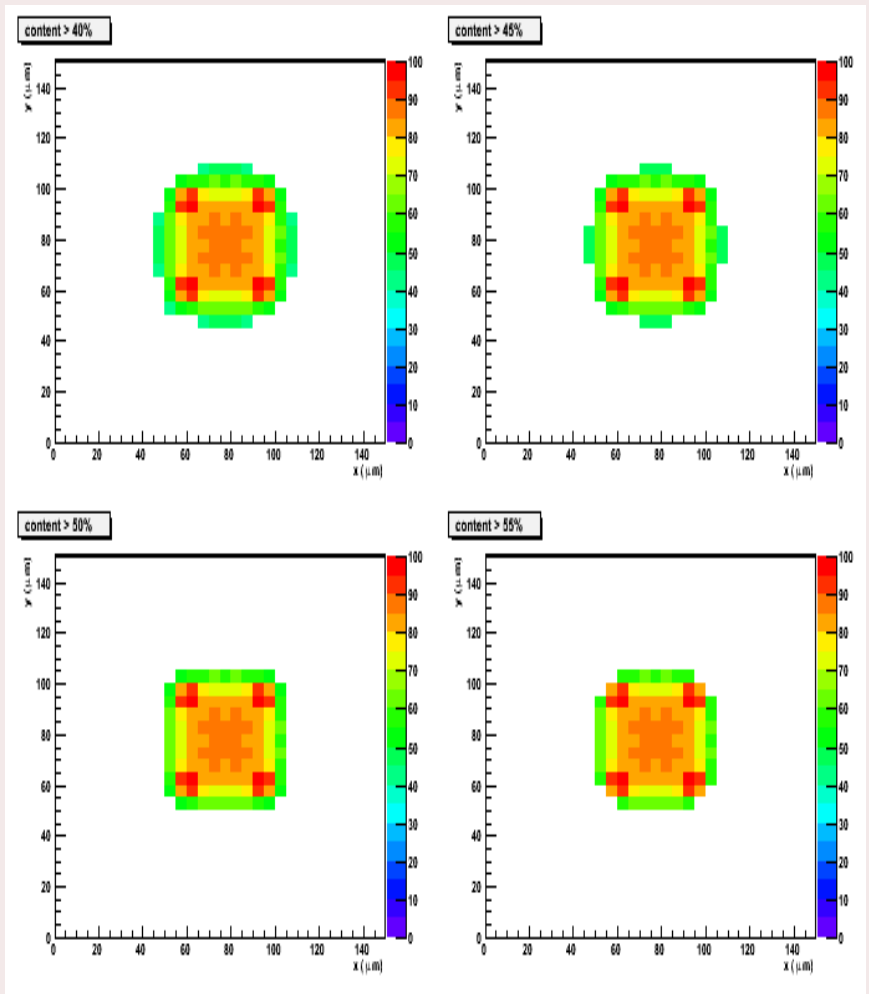


Full simulation, by comparison ... , continued...

GDS full simulation



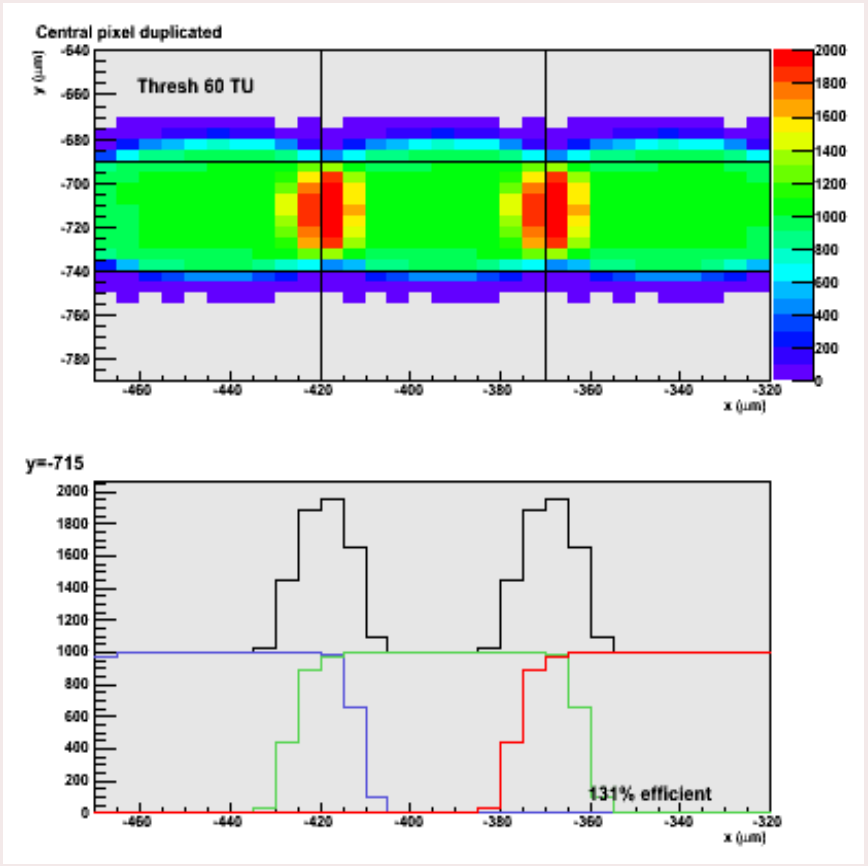
GDS assuming perfect p-well



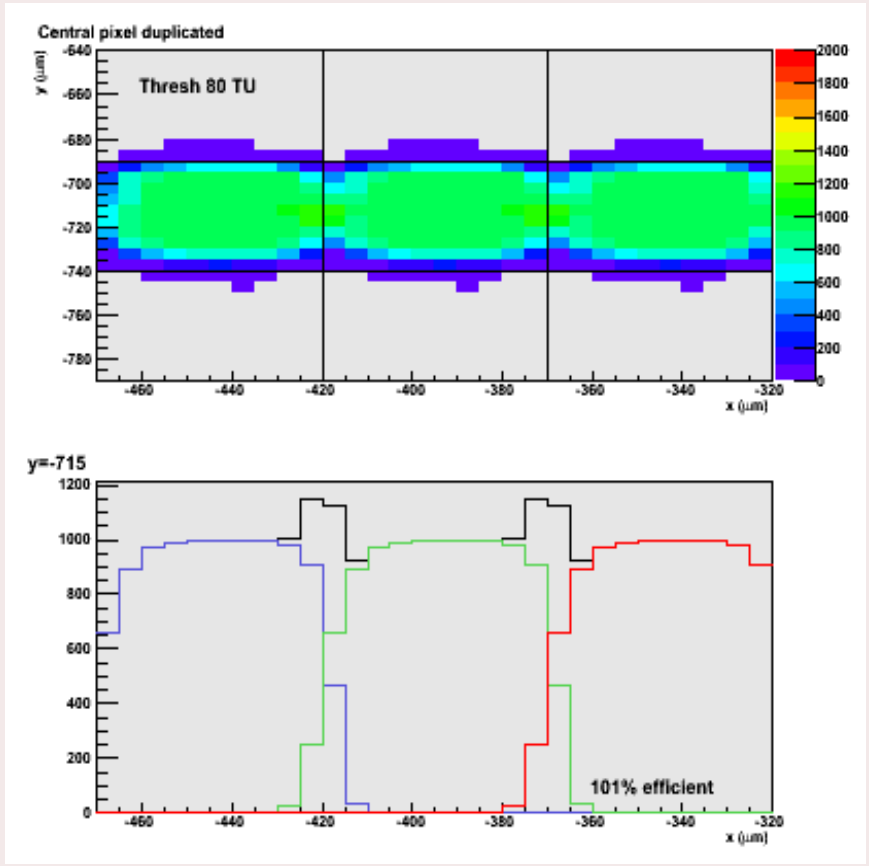
Outline

Uniformity in x: duplicating the central pixel

Threshold 60 TU : double counting

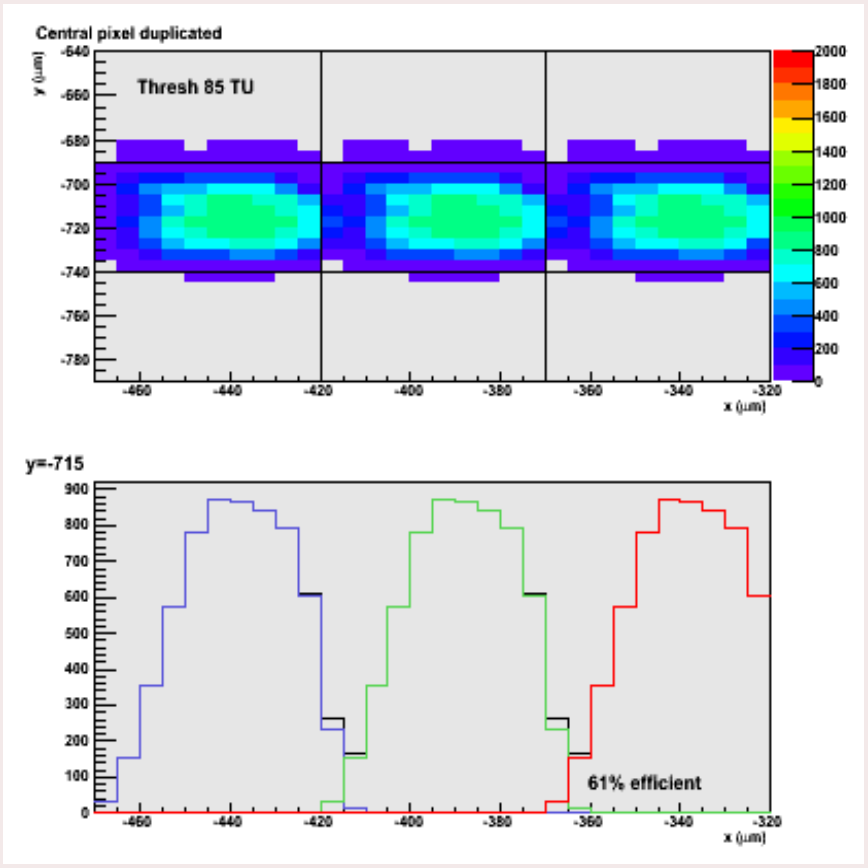


Threshold 80 TU : double counting

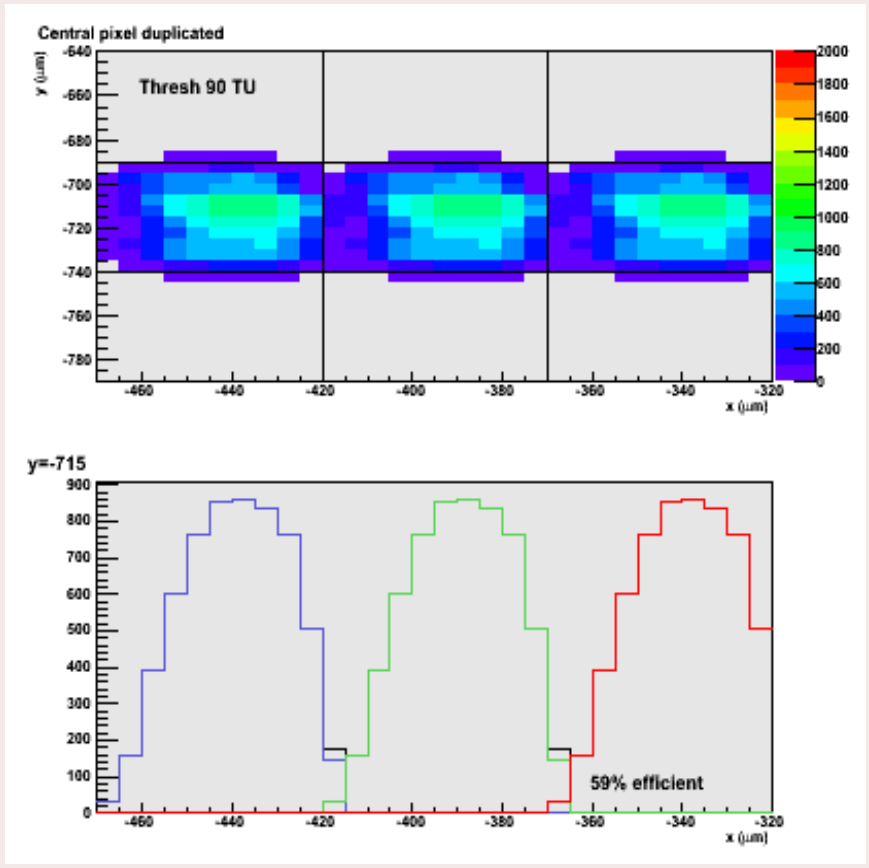


Uniformity in x, continued...

Threshold 85 TU : inefficiencies near the edges

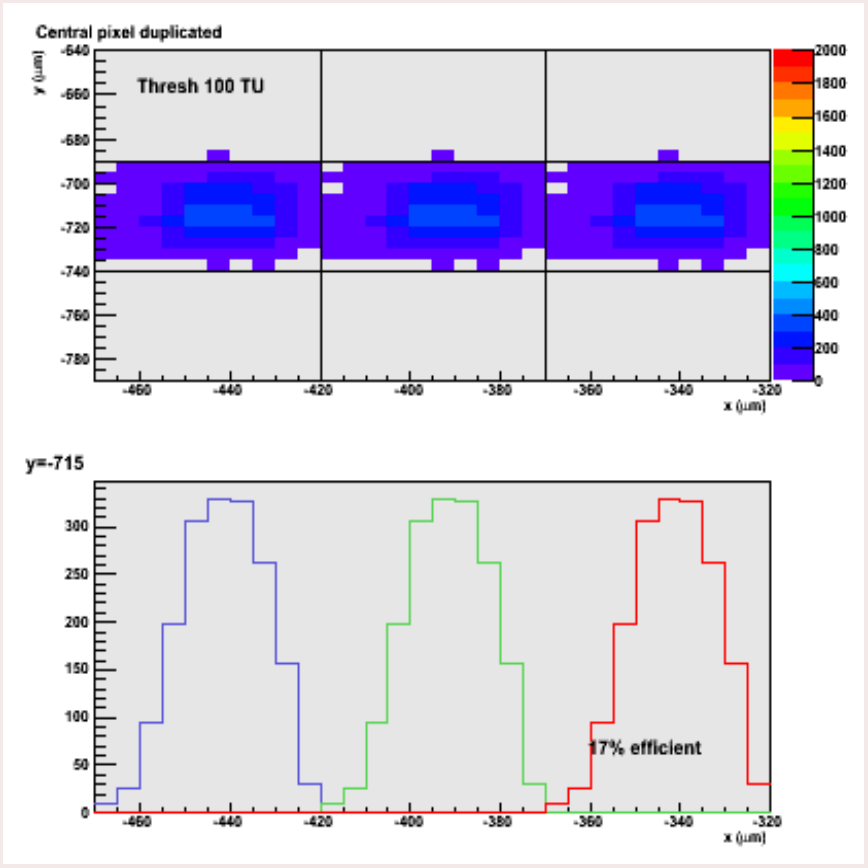


Threshold 90 TU : inefficiencies near the edges

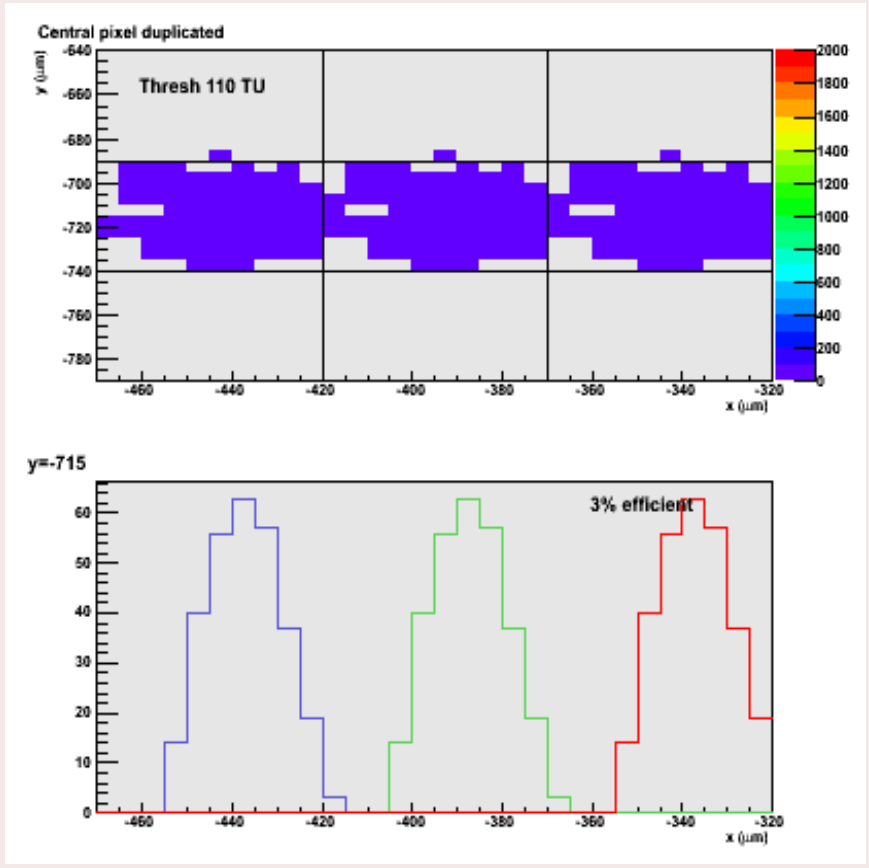


Uniformity in x, continued...

Threshold 100 TU : inefficiencies near the edges

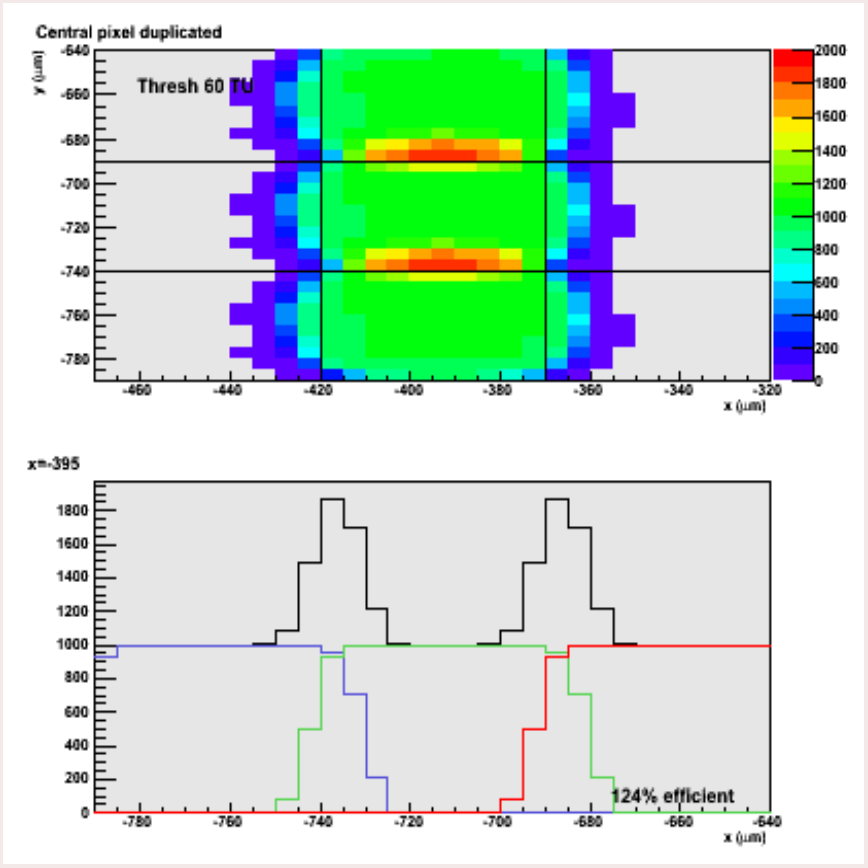


Threshold 110 TU : inefficiencies near the edges

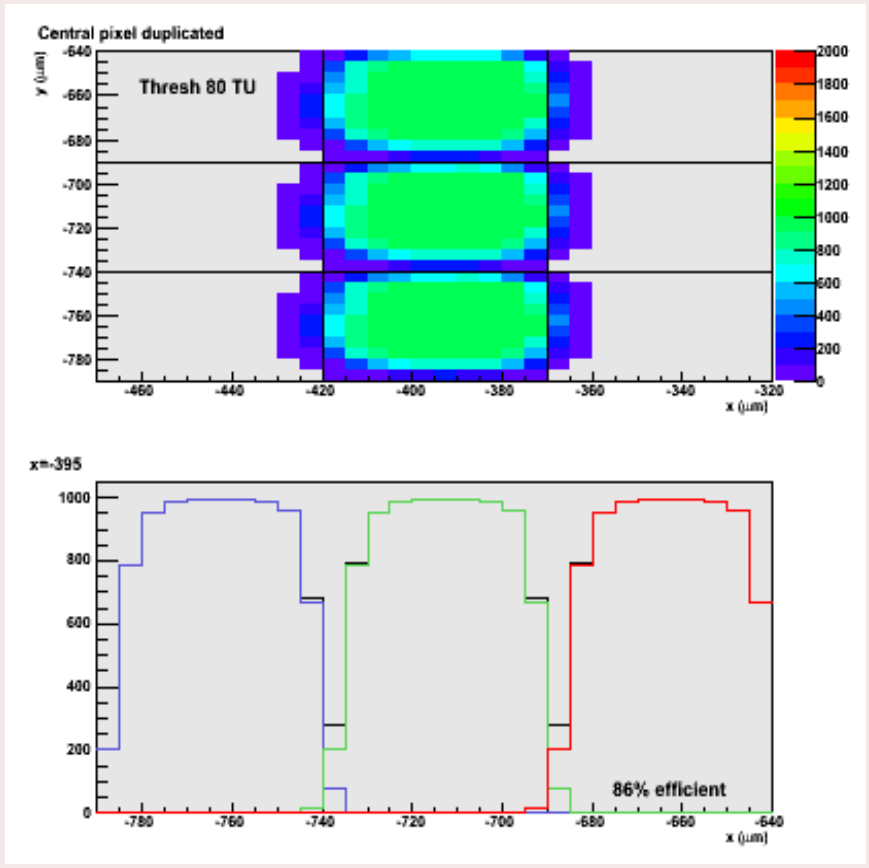


Uniformity in y: duplicating the central pixel

Threshold 60 TU : double counting

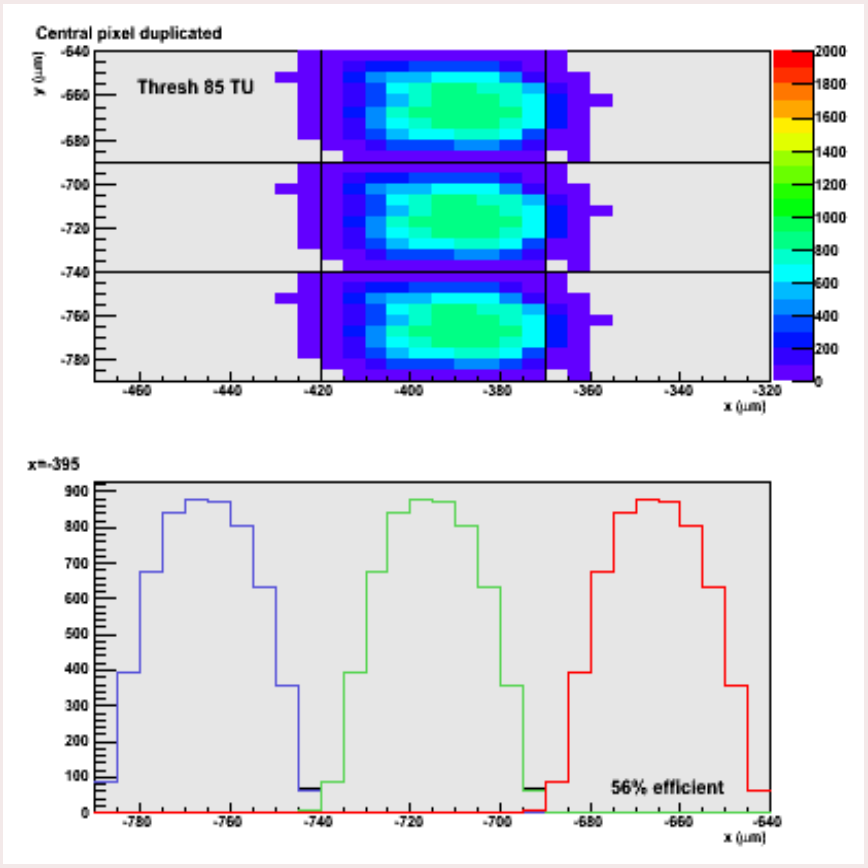


Threshold 80 TU : inefficiencies near the edges

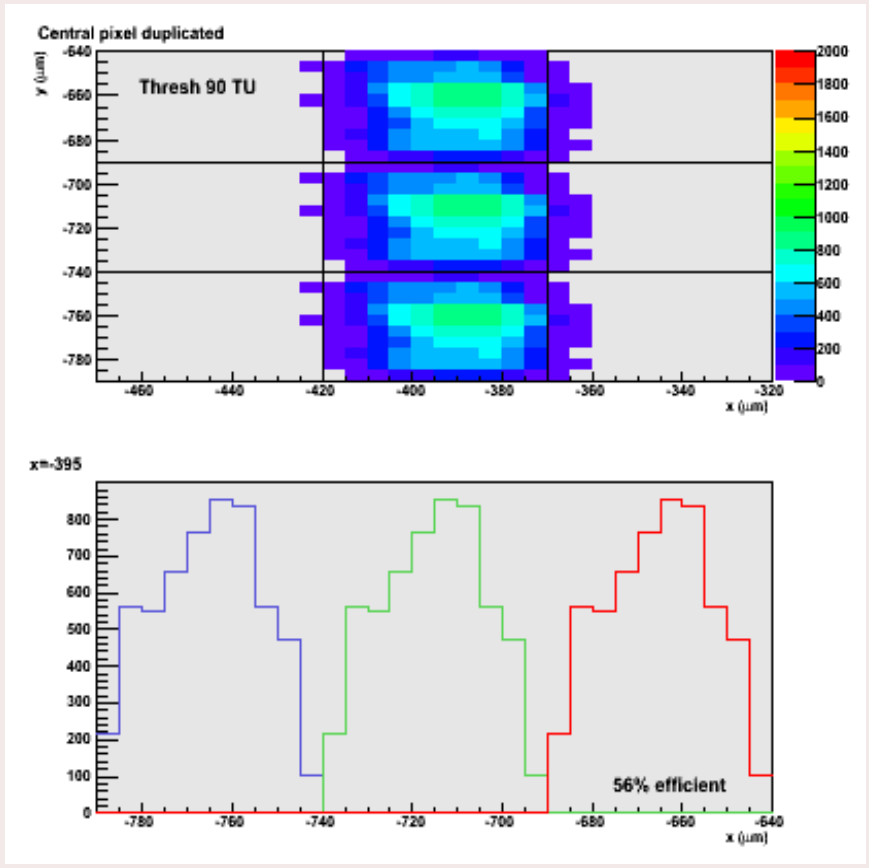


Uniformity in y, continued...

Threshold 85 TU : inefficiencies near the edges

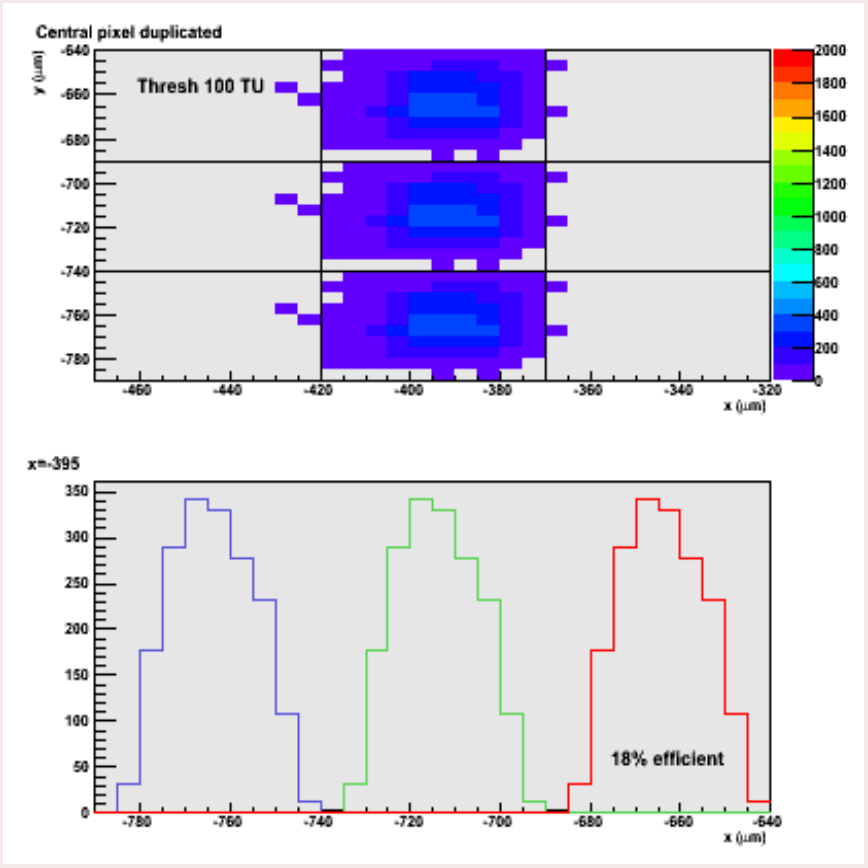


Threshold 90 TU : inefficiencies near the edges

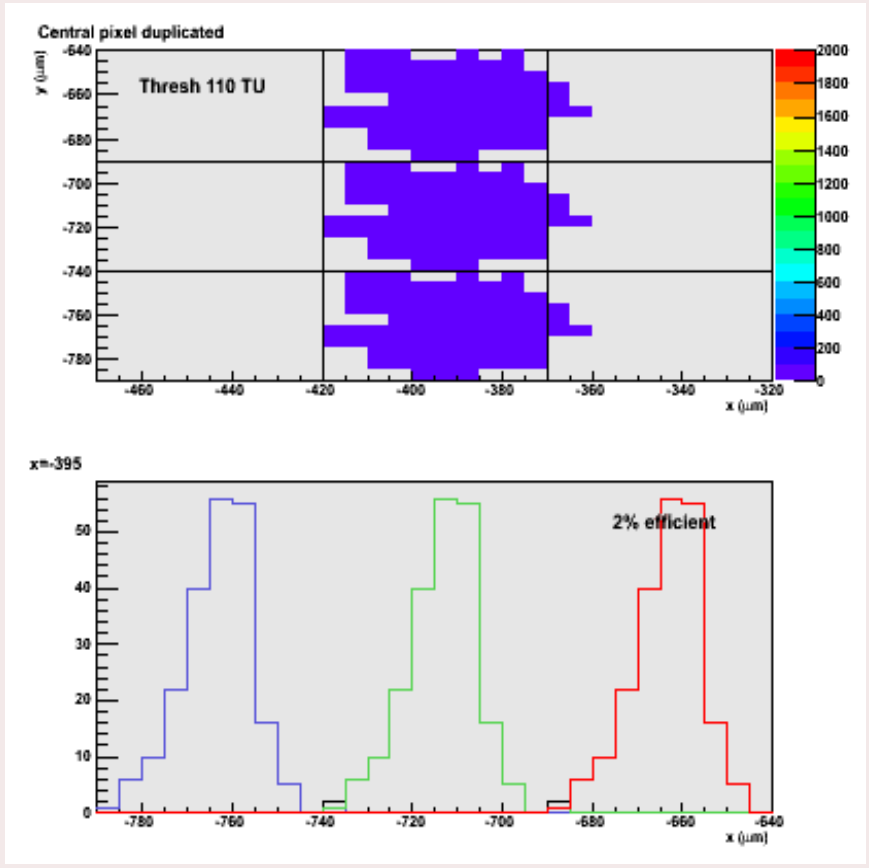


Uniformity in y, continued...

Threshold 100 TU : inefficiencies near the edges



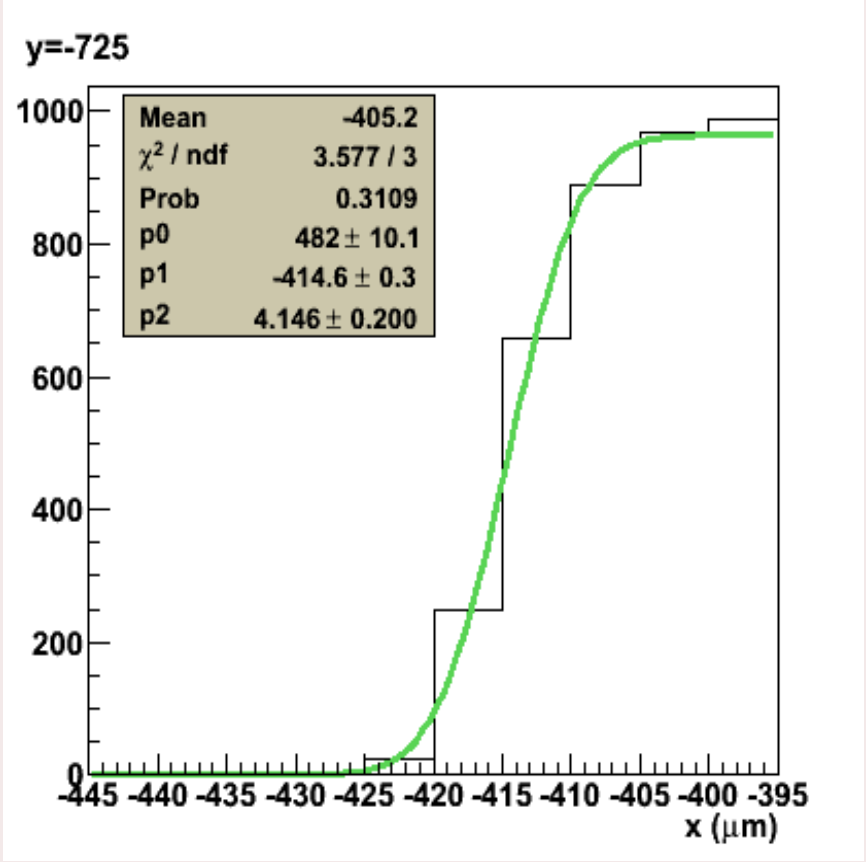
Threshold 110 TU : inefficiencies near the edges



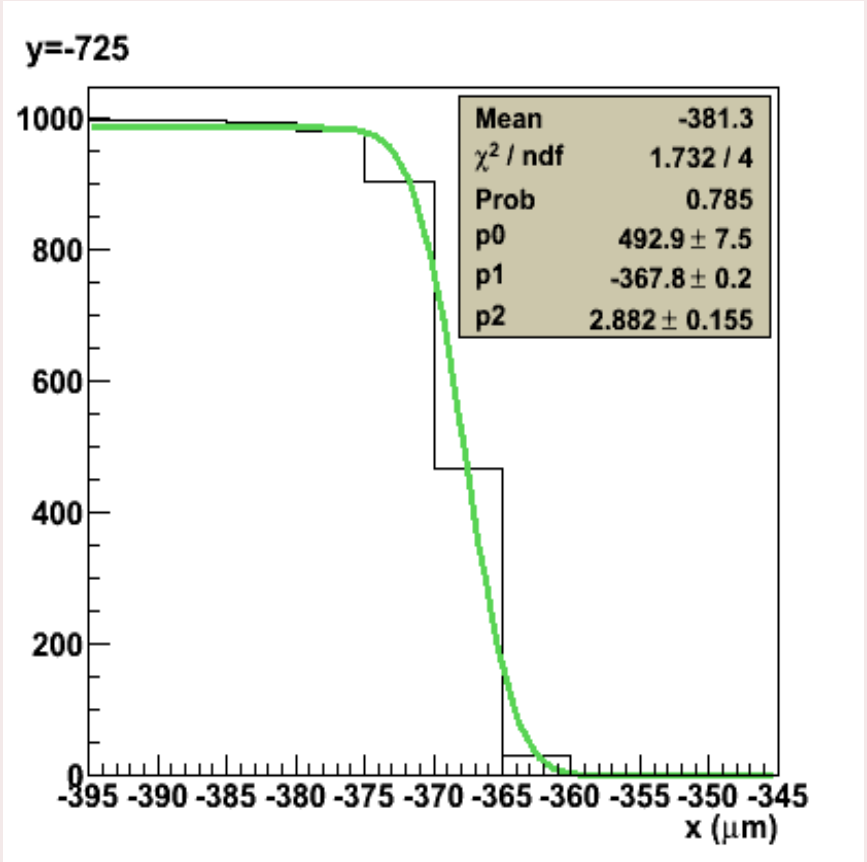
Outline

Rising and falling edges for central pixel

Threshold 80 TU: rising edge



Threshold 80 TU: falling edge



Fit with $\int_a^b Gauss(m, \sigma) = c \times TMath :: Erf(\frac{x-m}{\sqrt{2}\times\sigma})(+c)$

Threshold (TU)	σ_{rise} (μm)	σ_{fall} (μm)
40	4.92 ± 0.23	3.96 ± 0.28
60	2.91 ± 0.16	2.98 ± 0.16
80	4.15 ± 0.20	2.88 ± 0.16
85	5.92 ± 0.49	3.67 ± 0.18
90	5.29 ± 0.42	3.52 ± 0.14

$\Rightarrow$ Upper limit on laser spot size: 3 μm.

Conclusions

- Charge spread is very limited.
- Charge collection uniform (or saturated ?) inside the pixel.
- At very low threshold: appearance of a ring more efficient than the inside.
- Sharp loss of efficiency at increasing threshold (within 5 TU $\Rightarrow$ 40% loss).
- Full simulation shows diodes whatever scenario : not compatible with observation ?
- A threshold of about 65 TU (compared to “absolute 0”) gives best performance in terms of uniformity in x and y if we believe the pixels tested.
- Laser size estimated at 3 μm.